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# RESEARCH REPORT

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Experimental Farm  
LACOMBE, ALBERTA

RESEARCH BRANCH - CANADA DEPARTMENT OF AGRICULTURE

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*Research Report*  
*1962-1964*  
*Experimental Farm*  
*Lacombe, Alberta*

RESEARCH BRANCH  
CANADA DEPARTMENT OF AGRICULTURE

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## FOREWORD

This report summarizes the scope and results of research at the Experimental Farm, Lacombe, from 1962 to 1964. Further details are available on request.

The transfer in 1962 of two plant pathologists to the staff has widened the scope of the program and permitted close liaison between plant pathologists and plant breeders in the development of disease-resistant varieties.

The Lacombe breed of pigs, released in 1958, continued to fulfill its early promise. Developed through original research from a hybrid foundation, it has performed well, particularly as a crossing breed, under a wide range of conditions in all parts of Canada. The strong feature of the breed is its superiority in growth rate. Pigs of the breed have been exported to the United States, Great Britain, Germany, Japan, Russia, and Italy.

The performance of the Lacombe breed has shown that, with animals as with plants, new improved genetic combinations can be selected from hybrid foundations. It has also illustrated the soundness of selection on the basis of performance.

Park, a new variety of hard red spring wheat developed through breeding at Lacombe, and Pendek, a short, strong-strawed variety of oats introduced from Holland, were licensed for sale in Canada at our recommendation. Both of these varieties were well adapted for production in central Alberta.

Changing production patterns indicate that forage crops are increasing in importance in central Alberta and a breeding program was started to develop improved varieties of alsike clover. Red clovers resistant to northern anthracnose and winter crown rot are under study.

Intensive farming with large machines in recent years has introduced new problems in weed control. The efficiency of the new chemicals is evidenced by their increasing use and is a reflection of the careful research being done in this field. Of major significance were the results that led to the use of dicamba for the control of the weeds of the buckwheat family tolerant to 2,4-D.

From tests in the past there has been little evidence that potassium was an important fertilizer for central Alberta. Very recently it has been shown that in certain calcareous soils it could be a limiting factor. This finding illustrates the need for continuous research. It is also an example of the necessity for close cooperation between farmers and researchers as the first indication of the deficiency was demonstrated by a farmer.

The finding at Vegreville that nitrogen was of particular significance to productivity on Solonchic soils has opened the way to more consistent and higher yields on these soils.

February 1965

J. G. Stothart  
Director

## WEATHER

Meteorological data have been recorded daily at Lacombe since 1907. The following yearly summaries will explain some of the yearly variation in research results.

The 1962 crop season was preceded by a very dry fall, but winter precipitation was near normal and provided enough moisture to germinate cereal crops. The weather in April and early May was dry and windy and serious soil drifting occurred on several days throughout the district. Rainfall in May, June, and July was normal and there was a good first cut of hay and average yields of grain. Dry weather in August greatly reduced the second hay cut and pasture yield.

In 1963 moisture conditions were good for starting cereal crops but were too dry for good early growth of forage. Near normal rainfall in June and much above normal in July and August resulted in almost record yields of grains and heavy, although late, cuts of hay. Very dry weather in September and October and the absence of killing frost until October 7 allowed all crops, including silage corn, to be harvested in excellent condition.

The 1964 season illustrated rather dramatically the importance of the proper distribution of rainfall. The total precipitation in the growing season was only 1 inch less than in 1963, but the weather in July and the first three weeks of August was hot and rainfall was much below normal. Consequently, the yields of cereals approached the lowest on record. First-cut hay yields were about average and the heavy fall rains kept pastures green and productive somewhat longer than usual. The spring and fall months were cooler than normal, the first killing frost occurring on September 10.

## LIVESTOCK

### Beef Cattle

The Shorthorn herd at Lacombe is used for a long-term selection project for yearling weight, being carried out cooperatively with Indian Head and Brandon. In 1960, with the transfer of the Scott herd, the breeding herd at Lacombe was brought to its present size of 270 cows and 18 bulls. Of these, 6 bulls each mated to 15 cows constitute a control herd in which genetic change is kept to a minimum, and the remainder, 12 bulls each mated to 15 cows, constitute a selected herd, in which all bulls and about 25% of the cows are replaced annually by the yearling animals that have attained the greatest yearling weight on a standardized performance test.

Since selection was first applied (1960 calf crop) the selected line has invariably surpassed the control line in yearling weight. Although the two sexes have not behaved in the same manner, the average response has been  $0.58 \pm 0.20$  units per unit of selection, indicating a heritability of about 60%.

## Swine

*The Lacombe breed*—Released to the public in 1958, the Lacombe breed has continued to expand and develop in the hands of private breeders across Canada. Registrations in 1964 were 2,326 and accounted for 11% of all registrations issued for purebred pigs during the year. The total number of Lacombes registered to the end of 1964 was 10,600. Registered Lacombe breeding stock has been exported to the United States, Japan, United Kingdom, Germany, Italy, and Russia.

The breed has been extensively tested under the Canadian Record of Performance testing program. It has consistently reached market weight earlier than other breeds tested and has produced carcasses of about the same merit.

*Ovulation rates*—Ovulation rates in the Lacombe breed were estimated by corpora lutea counts made after slaughter at  $50 \pm 4$  or  $100 \pm 4$  days of gestation. Mean corpora lutea counts were  $14.5 \pm 3.2$  for gilts and  $21.4 \pm 4.4$  for sows. These rank with the highest rates reported for other breeds of pigs. The evidence indicated that ovulation rate was subject to a high degree of genetic control but was not highly correlated with litter size at the stages of pregnancy examined.

*Rib and vertebral numbers*—For 10,683 pigs of two breeds and their crosses produced over an 8-year period, the number of rib pairs ranged from 13.5 to 17.0 and the number of presacral vertebrae (excluding cervical) from 20 to 23. The breeds and crosses studied had the same range of variability but differed in frequency of the various rib and vertebral classes. The average regression of rib number on vertebral number ranged from 0.62 for Lacombe females to 0.77 for Yorkshire females. Bilateral asymmetry in rib number was observed in 6.5% of all pigs, and 41% of the 1,147 litters examined contained asymmetrical pigs. The number of ribs and vertebrae (thoracic and lumbar) of pigs within litters varied often; the maximum observed range was 2.5 ribs and 3 vertebrae. Complete uniformity of litter mates in rib number, in vertebral number, and in both traits was observed in 23, 31 and 13% respectively of all litters. Males and females were similar in average rib and vertebral number and in frequency of asymmetry. The variation in the skeletal traits was not associated with viability.

Genetic parameters for rib and vertebral number in swine were estimated from data for 4,219 pigs produced by 78 sires and 359 dams of the Lacombe breed. Regressions of offspring on midparent were  $0.599 \pm 0.017$  for vertebral number and  $0.734 \pm 0.020$  for rib number. The corresponding full sib correlations were estimated as  $0.813 \pm 0.022$  by the regression of offspring on midparent and  $0.792 \pm 0.16$  by the analysis of components of covariance.

Continuous genetic variation for both traits was demonstrated. The modal phenotype (i.e., 16 pairs of ribs and 22 vertebrae) produced progeny more uniform for both traits than did parents of nonmodal phenotypes. Bilateral asymmetry (within-pig variance) was also least among progeny of modal parents.

*Skeletal anomalies*—Skeletal anomalies, mainly of the axial skeleton, occurred with a frequency of 0.28% in the 10,683 pigs studied. Most frequent of these anomalies were fusion of vertebrae and incomplete development of one or more vertebrae. There was no evidence of an inherited predisposition to abnormal development and it was concluded that the anomalies studied were

manifestations of metabolic disturbances of nongenetic origin occurring at different stages and/or with variable intensity during embryonic development.

*Litter size and pre- and post-weaning performance*—Analysis of performance data from 209 barrows and 222 gilts, representing 135 gilt litters, showed an important inverse relationship between litter size at birth and weaning and individual pig weights at both ages. Differences in litter size at weaning had no measurable influence on the post-weaning traits of average daily gain during the weight-constant growth period of  $50$  to  $195 \pm 3$  pounds or on the carcass traits of length and loin area. There was reasonably consistent evidence of a small effect on total back fat, females from small litters producing a greater amount of fat than expected in relation to their contemporary test barrows. These relationships were confirmed by analysis of a further sample of 149 barrows and 147 gilts from 82 litters.

### Carcass Studies

*Prediction of yield and value of hog carcasses*—Relationships between a number of split and internal carcass measurements and yield of the carcass and its component cuts, when trimmed in accordance with commercial standards, were examined on a sample of 482 hog carcasses. Carcass length and weight had low predictive value, accounting respectively for about 9 and 4% of the total variance in yield of the trimmed lean cuts (ham, loin, picnic, and butt). Commercial grade accounted for about 27% of the variance in this trait and sex about 21%. The most useful predictors of yield of lean cuts and the percentage of total variance accounted for by each were: yield of trimmed loin, 83%; ratio of loin area to total back fat, 53%; total back fat, 54%; and lean in the ham face, 43%. A regression equation combining total back fat, loin area, and lean in the ham face accounted for 63% of the total variance.

*Photography as an aid in carcass evaluation*—A technique has been developed for measuring the proportion of fat, lean, and bone in cross sections of carcasses using a camera, simple enlarging equipment, and a planimeter. The technique is particularly useful for cuts that, because of complex tissue patterns, are not amenable to direct tracing. Even for simple cuts (e.g., area of longissimus dorsi), photography provides a permanent record possessing considerably greater detail than is possible in a tracing.

*Relationship between specific gravity and chemical analysis of hams*—Chemical analyses and specific gravity were obtained on 120 hams, 60 from barrows and 60 from females. Females produced hams that were superior in lean content and cut-out yield to the hams of barrows.

Although the correlations of specific gravity with percentages of protein, fat, and ash were highly significant for both sexes, these correlations were decidedly lower than those reported by other workers.

It was concluded that our correlations were biased downwards because of the methods used in handling the hams before specific gravity determinations and chemical analysis. The hams could not be chilled uniformly. Freezing of the hams caused cell membranes to rupture so that moisture was lost on thawing. Density of the meat varied because all hams were not brought to the same temperature before specific gravity determinations were taken. These observations show that definite procedures must be followed if specific gravity is to provide a reliable guide to carcass or ham composition.

## Laboratory Animals

Laboratory mice are being used at Lacombe in an attempt to obtain a comprehensive assessment of the antagonistic effects of inbreeding and selection in closed populations of the size encountered in many livestock-breeding enterprises.

Four strains of mice are being used and, within each, replications are maintained on different levels of inbreeding (2%/generation vs. 6%/generation) and selection (within-litter selection for mature body weight vs. no selection).

## PLANT BREEDING

Work on plant breeding is directed towards improving varieties and strains of wheat, oats, barley, red clover, alsike clover, potatoes, tomatoes, bush fruits, and tree fruits through breeding and selection. Evaluation of species, varieties, and strains of cereal, forage, and horticultural crops for production in central Alberta is also an important part of the work. Methods of improving techniques for selection and testing are given attention and special problems of farmers are studied to establish better practices for growing crops.

### Cereal Crops

*Wheat*—The breeding of wheat, directed mainly towards developing new early-maturing varieties for northern areas and coordinated from Lacombe since 1949, was formally discontinued in 1964. The breeding material on hand will be processed but no new work will be started. This action was taken to permit greater emphasis on the breeding of barley and oats, the two most important crops in the area served by Lacombe.

Park, a new hard red spring wheat developed at Lacombe from the cross (Mida  $\times$  Cadet)  $\times$  Thatcher, was licensed and seed was distributed to seed growers in 1963. This variety is similar to Thatcher and Saunders in resistance to disease, is as early as Saunders, approaches Thatcher in yield, and is easier to thresh than Thatcher. After 2 years of field production, growers in central Alberta are looking upon Park with favor. There are indications that it may displace most of the Saunders and a fair amount of the Thatcher being grown in this area.

The study on the relationship between maturity, yield, and quality begun in 1959 had advanced to the initial yield-testing stage by 1964. Yield and other agronomic data plus preliminary quality figures were obtained on 110 of 432  $F_2$ -derived lines from the cross Prelude  $\times$  C.T.423, which had been propagated to the  $F_8$  through random sampling. A wide range in yield, maturity, and protein content was evident in material under test in 1964.

Evaluation of the merits of established and newly licensed varieties confirmed previous findings that Thatcher, Canthatch, Park, and Saunders are the best varieties for production in central Alberta. Pembina, licensed in 1959, and Cypress, licensed in 1962, were not satisfactory to the area.

*Oats*—With yield and maturity as the primary considerations, random sampling is being evaluated as a method for oat breeding. Parents were selected on the basis of yield-to-maturity ratios, and 10 crosses were made. At least 300 lines from each cross will be propagated through random sampling until

homozygosity is reached, and then yield testing will be started. Individual plant selection will be practiced only within the few lines that exhibit superior characteristics in the yield test. Paired comparison tests on two crosses were conducted in 1964 and a good range in yield was noted.

Pendek, an introduction from Holland, was licensed in 1963, on our recommendation. This variety has very short straw and is highly resistant to lodging. It is medium early in maturity and is as productive as Rodney in central and northern Alberta. Pendek will prove useful on high-producing land where lodging and excessive length of straw are problems with existing varieties.

In large breeding programs the use of single-row plots for yield testing could lead to considerable saving in land and labor. However, in a 3-year study at Lacombe, yield results from single rows were unreliable when compared with those from multiple-row plots.

Periodically, reports reach Lacombe of damage to oats from gray speck (manganese deficiency) in scattered localities throughout central Alberta. In 1964 a new method of control was studied. Manganese ammonium phosphate, a compound that slowly releases manganese, was added to a medium in which oat seeds were pelleted. The pellets were treated with a mercuric seed dressing to protect the manganese from the action of soil microorganisms that normally make it unavailable to plants. In a test on peat soil in west-central Alberta, the treated seed produced a crop that yielded about 25% higher than that from checks, and there was no manganese deficiency.

Evaluation studies on established and newly licensed varieties of oats were continued. The newly licensed varieties included Pendek and Russell. The latter failed to show any marked advantage over presently established varieties, which include Victory, Eagle, Rodney, Garry, and Glen.

*Barley*—The objectives in barley breeding are to develop varieties that possess a combined resistance to smut, scald, and net blotch without sacrificing yield, other desirable agronomic characteristics, or quality. To achieve these objectives a backcrossing program was started in which suitable disease-susceptible varieties are used as recurrent parents in crosses with varieties highly resistant to each of the above diseases. When reconstituted resistant varieties are developed, they will be used freely in new combinations.

Coincidental to breeding and selection, research on diseases has been carried out to aid in choosing parents and in screening material for resistance to disease. Up to now most of the emphasis has been on a study of *Drechslera teres* (Sacc.) Shoemaker, the causal agent of net blotch in Alberta.

In culture studies, the difficulty in maintaining virulence was attributed to the prolific production of an avirulent nonsporulating mycelial variant. The development of the avirulent form was retarded by reducing the sugar content of the media. The two forms of the fungus differed in their growth rates in response to temperature, pH, and nutrients in the substrate. The degree of virulence and the morphology of the mycelial form was unaltered by changes in these conditions, unlike that of the conidial, virulent isolates.

Enzyme activity in the parasite-stimulated host tissue with and without specific inhibitors showed that the fungus-stimulated oxygen uptake in susceptible Gateway leaves was mediated in part by flavoenzymes and cytochrome oxidase whereas in resistant Colonial-2 leaves it was mediated in part by ascorbic acid oxidase. Peroxidase activity was stimulated in both varieties on

infection. The activity of the enzymes might suggest the importance in diminishing the reducing substances and thus regulating the development of oxidized phenol, the appearance of which might limit development of *D. teres* in Colonial-2 leaves. Isotope data, which indicated the enhanced participation of the phosphate pentose pathway with its attending increase in TPNH in diseased Gateway, provided further support for this theory.

Noninfected Colonial-2 barley leaf juice caused a more marked inhibition of *D. teres* than that from Gateway grown under greenhouse conditions. Colonial-2 leaves maintained 3 days in the dark were no longer resistant and leaf expressates indicated a decrease in an ultraviolet-absorbing compound (270 m $\mu$ ) that was antagonistic to the growth of *D. teres*. The antifungal material was isolated by chromatography ( $R_F$  0.9). There was less antifungal substance in susceptible Gateway leaves. The avirulent, mycelial isolate grew poorly or not at all on leaf expressates or ether extracts from leaves of both barley varieties. The presence of higher levels of  $\beta$ -glucosidase activity in the culture filtrate of the avirulent isolate suggested that this enzyme, or naturally occurring  $\beta$ -glycosidases in the leaf, hydrolyze leaf glycosides to release phenols. Subsequent oxidation of phenols in the leaf might retard the growth of the fungus, especially the avirulent form, which was found to be inhibited more readily in the presence of a number of phenol compounds.

Studies on the effects of seed size on plant development and disease were continued in cooperation with the Department of Genetics, University of Alberta. In field tests, three seed sizes and three seeding rates for each of three varieties were used. Results showed that emergence was not influenced by seed size, but culm counts and yields were highest from large seeds for all rates with all varieties. The seeding rate  $\times$  seed size interaction was not significant. The lowest seeding rates for all sizes produced the heaviest kernels and vice versa.

For seeds naturally infected with loose smut, lateral kernels produced more smutted plants than central kernels. The percentages of infected kernels from the upper, middle, and lower parts of the spike varied with no fixed pattern. These studies corroborated previous findings that the percentage infection in small kernels was greater than that in large kernels.

Results reported in the 1958-1961 report indicated that if a valid measure of the genetic variation between varieties is to be obtained the seed used in any given test should be produced under similar conditions. Subsequent tests have added further evidence to these conclusions. In 1963 and 1964 the studies included varieties of wheat and oats as well as barley and differences attributed to seed source were as high as 10% in some tests.

In evaluation studies of established and newly licensed varieties of barley, Jubilee and Husky gave the highest yields and Olli the lowest. The newly licensed varieties Betzes and Gateway 63 showed promise for production in central Alberta but Keystone failed to perform as well as established varieties maturing at the same time. Those best suited to central Alberta include Jubilee and Husky as late, Parkland and Betzes as medium, and Gateway and Gateway 63 as early maturing varieties. Some Olli is still being grown for its malting quality.

### Forage Crops

*Red clover*—Combined resistance to northern anthracnose, caused by *Kabatiella caulivora* (Kirchn.) Karak., and winter crown rot is being sought in the breeding of red clover varieties. Several cycles of mass selection for

agronomic traits were completed by 1961 when the selected material was evaluated for resistance to winter crown rot. Resistant strains and progenies have been successively inoculated with *K. caulivora* and surviving resistant plants are now being evaluated for forage and seed yield in polycross nurseries.

By the colchicine technique, tetraploidy was induced in very winter-hardy red clover stock of Siberian origin in 1961. The material has been propagated to restore satisfactory levels of fertility and in the fall of 1964 seed stocks were selected for further study.

Contract seed production of foreign varieties has possibilities for the export market. To evaluate foreign as well as domestic varieties for both forage and seed production, cooperative tests were established in 1964 with Melfort, Scott, Beaverlodge, and Prince George.

*Alsike clover*—Resistance to winter crown rot is important in alsike clover. Diploid and tetraploid material is included in the program and several promising selections are in the progeny testing stage. European material of the erect growth type generally gave high yields of forage but yields of seed were 20 to 40% lower than for Canadian material.

Two mechanically transmissible viruses identified as bean yellow mosaic virus and Wisconsin pea streak virus were found in clovers at Lacombe in 1963. In 1964 damage from the viruses was evident at several localities in central and northern Alberta. Although the bean yellow mosaic virus was more severe and affected yield, it was not as widespread as the Wisconsin pea streak virus.

*Adaptation studies of forage crops*—The brome grass variety Carlton out-yielded Commercial in seed production by an average of 12% over a 3-year period and was similar in forage yield. Varieties of the southern type such as Saratoga and the recently licensed Canadian variety Redpatch were much lower in seed production but equal or slightly superior to Commercial in forage production.

Cooperative grass tests seeded in 1964 included Astra, a new variety of timothy; Sawki, a new variety of Russian wild rye; plus a number of promising new lines of creeping red fescue.

In some tests on pubescent wheatgrass, Topar, Mandan, and selected lines compared favorably with other adapted varieties, whereas in others they were inferior. At Lacombe none of the varieties of pubescent wheatgrass displayed the outstanding earliness of spring growth they are reputed to possess.

Continued trials with alfalfa varieties confirmed the value of Beaver and Ladak for hay mixtures and of Rambler for pasture. Varieties of French or Scandinavian background such as DuPuits, Alfa, and Tuna were not as productive nor as winter-hardy as Beaver and Ladak.

Cumino and Denta, two coumarin-free varieties of sweet clover, gave satisfactory yields of forage but their lateness made seed production hazardous.

In 1962, blackstem, a disease that attacks several legumes, was prevalent in sweet clover at Lacombe. Alpha was very susceptible and sensitive to the disease (rating 4.83 on a scale of 1-5), Brandon Dwarf was the most resistant (1.50) and other varieties were intermediate (Cumino and Erector, 1.83; Madrid, 2.16; Arctic, 2.30; and Denta, 2.50).

Extensive tests on corn varieties for silage were carried out from 1962 to 1964. Although the latest maturing varieties or hybrids generally gave the highest yields of dry matter, cob formation could not be relied on. Corn yields

were exceptionally high in 1963 but in 1964 yields of oats for silage were considerably higher than corn. Algonquin and Rainbow Flint were the best producing varieties of corn.

*Management studies*—In past trials with birdsfoot trefoil-grass mixture the trefoil did not contribute significantly to yield. Further tests showed that birdsfoot trefoil is more sensitive to shading than other commonly grown legumes. When natural light was restricted 50% to trefoil plants in the seeding year, top growth was reduced by 25% and root growth by 51%.

When forages were seeded with companion crops, sweet clover and birdsfoot trefoil were the species most handicapped by competition whereas alfalfa and the true clovers established satisfactorily. Yields from stands established with companion crops were lower in the first year of production but in the second year they equaled those from crops established without companion crops.

*Oilseed crops*—The Polish types of rapeseed continued to mature satisfactorily, whereas the varieties of the Argentine type were periodically damaged from early fall frosts. The average yield of Polish types was about 400 pounds of seed per acre per year more than the Argentine types. Echo, a Polish type licensed in 1964, was superior to the variety Polish and compared favorably with Arlo.

### **Horticultural Crops**

Major breeding projects on tree fruits, tomatoes, and potatoes are conducted in cooperation with other units of the Research Branch, universities, and the Provincial Horticultural Station. Studies on cultural procedures to promote earlier ripening and higher yield for many crops, and variety testing on all crops suited to the region are important phases of the horticultural program.

*Tree fruits*—The year 1964 was the 10th season for most of the apple × crabapple seedlings being evaluated at Lacombe in the Prairie Cooperative Fruit Breeding Project. From 1961 to 1964, the percentage fruiting was 4.5, 15.7, 57.2, and 75.5 respectively. All seedlings in the Florence × Melba, Trail × Robin, and Redant × Osman lines have fruited and evidently mature earlier than the remaining 19 lines on test.

Results to date indicate that fruit much over two inches in diameter cannot be expected. Although several seedlings, mainly from the crosses Florence × Melba, Rescue × Melba, and Rescue × Mantet, have approached or slightly surpassed this size, the mean of all varieties was 1.4 inches equatorial and 1.5 inches polar diameter. Five lines (four of which have Rescue as one of the parents) were superior in fruit size and quality.

Current selections are undergoing final evaluation for hardiness, resistance to disease, fruit size, and fruit quality.

*Raspberries*—Of the recent raspberry introductions the Morden varieties Boyne and Killarney are noted for their large-sized fruit and vigorous canes. Boyne averaged 20.1 pounds for a 30-foot row and Killarney 28.8 pounds during the 3-year period. However, the average winterkill for Boyne was only 12% compared with 38% for Killarney. Honeyking, the standard for hardiness, averaged less than 10% winter injury and yielded 23.3 pounds per plot. Its fruit, however, is only slightly superior to that of the native raspberry.

*Tomatoes*—A tomato selection designated LC14 is being introduced for wider test. It was developed from a backcrossing program with Farthest North

and Early Chatham, the latter being the recurrent parent. Fruit is small, but is four times the size of Farthest North and just as early. During the past two seasons LC14 averaged 11 days earlier than B4 and 19 days earlier than Earlinorth, the two varieties used as parents for earliness in the cooperative breeding project. In 1964, a rather poor year for tomatoes, LC14 matured in 72 days. No ripe fruit was harvested from Early Chatham.

*Potatoes*—Fertility trials were conducted in the 3 years on a Peace Hills fine sandy loam. No significant yield differences were obtained in 1962, an average season, or in 1964, a cool dry season. In 1963, an above-average season for moisture distribution and general growing conditions, only the highest combined rates of 100 pounds N per acre, 100 pounds  $P_2O_5$ , and 50 pounds  $K_2O$  produced a significant increase over the checks.

The fertilizers did not improve the percentage of dry matter or the cooking quality of the tubers. Quality determinations were made at harvest and after 5 months in storage. Many of the samples showed after-cooking darkening, but there was no consistent pattern that could be attributed to any particular treatment whether fertilized or not.

*Mulch trials*—It has been established that polyethylene mulches hasten maturity and increase yields of sweet corn, cucumbers, and muskmelon. Recent tests showed that watermelons, peppers, and gladioli benefit in a similar way from plastic mulching.

Tenfold increases in yield were obtained from plots of Early Canada watermelon mulched with 1.5-mil clear polyethylene, but only in favorable growing seasons. With early varieties of peppers, yields increased three- to five-fold in most seasons. For early, midseason, and late varieties of gladioli, the plants emerged from 3 to 6 days earlier and flowered from 6 to 8 days earlier.

## CROP MANAGEMENT AND SOILS

### Plant Nutrition

Attempts to delineate, by extensive field tests, the nutritional requirements of cereal and forage crops on a soil type or soil group basis have been largely abandoned because of the variability of response obtained. Past crop sequence, tillage practices and fertilization contributed to this variability but could not be standardized in tests on farmers' fields. New studies have been started at a few locations where these factors can be largely controlled. Soil and plant analyses are being carried out to determine their usefulness as predictors of the fertilizer requirements on soils.

*Soil sulphur*—Plant-available sulphur in soil was not delineated by sulphur: soluble in water and utilized by *Aspergillus niger*; soluble in water and reduced to  $H_2S$  by a mixture of hydriodic, formic, and hypophosphorous acids; or reduced to  $H_2S$  by direct treatment of the soil with the above reducing mixture.

The three fractions were evaluated on 20 Gray Wooded and Dark Gray soils on which response of alfalfa to sulphur fertilizer had been determined in a growth chamber. The fraction utilized by *Aspergillus niger* was decreased by four cuttings of alfalfa made at 2-month intervals. In a similar study in which radishes were used as the test crop, water-soluble sulphur reduced by hydriodic, formic, and hypophosphorous acids did not correlate with yield response to sulphur fertilization or to uptake of sulphur by the plants.

Sulphate was found to accumulate in moderate amounts at depths of 1 to 4 feet in field soils now being evaluated for sulphur deficiency. Perfusion with distilled water for a 3-week period did not release sulphate from the surface soils alone but added elemental sulphur oxidized to sulphate.

*Potassium deficiency on calcareous soils*—Yield increases as great as 30 bushels per acre for both barley and oats were obtained from the application of fertilizer containing potassium at five localities in the Ponoka-Lacombe area in 1964. The five tests were on soils with free lime in the surface horizon. Plant-available potassium extracted with neutral and acidic extractants was much lower than for the adjacent noncalcareous soils. Visual symptoms of the potassium deficiency were a very uneven growth and necrotic areas on the tips and margins of the older leaves. Nonaffected areas of the leaves retained a normal green color. This is the first evidence of any appreciable area of potassium-deficient soils in Alberta.

*Nitrogen deficiency in cereal crops*—Symptoms of nitrogen deficiency in cereal crops have become increasingly prevalent in recent years throughout north-central Alberta. The symptoms generally appear during late June and early July. In a number of field experiments, topdressings of nitrogenous fertilizer were beneficial. About 20 pounds of nitrogen per acre were enough to overcome moderate symptoms of nitrogen deficiency whereas 40 to 60 pounds were required to alleviate severe symptoms. Maximum benefits were obtained when the topdressing was applied before the shot-blade stage.

*The accumulation of nitrate in several perennial forages*—Samples of creeping red fescue, brome grass, and alfalfa grown in simulated pasture trials and fertilized with nitrogen alone and in combination with phosphorus and potassium were analyzed to determine their nitrate content. The plant samples represented three dates of cutting from three levels of fertility: nil, low fertility (N at 16 lb per acre,  $P_2O_5$  at 20 lb), and high fertility (N at 128 lb per acre,  $P_2O_5$  at 50 lb). Very little nitrate had accumulated in plants in the control and low fertility treatments, nor was there appreciable accumulation at any fertility level at either the first or third cutting date. Considerable nitrate had accumulated (up to 1.49%  $KNO_3$ ) in the plants at the second cutting date from plots fertilized at the high rate of nitrogen. However, in no instance did the accumulation exceed the generally accepted toxic level of 1.5%.

Adding phosphorus along with the high rate of nitrogen reduced nitrate accumulation by a third or more. Potassium had only a slight effect on the level of nitrate. Of the three forages studied, brome grass was the greatest accumulator of nitrate after fertilization. The accumulation of nitrate in fescue and alfalfa was generally about half that in brome grass, alfalfa having slightly higher levels than fescue.

*Peat soils*—Several hundred thousand acres of sphagnum and sedge peat soils occur in pockets of a few acres to several thousand acres in size in western Alberta. Much of this land is potentially arable, but for various reasons much of the peat under cultivation is not producing satisfactorily. An area of sedge peat soil on the Leslieville project farm was selected for intensive study in 1963. Soil and air temperatures, water table, and precipitation are being recorded and correlated with growth and productivity of various forage crops. Early results indicate that brome grass, adequately fertilized, is adaptable for hay production on these soils.

*Gray Wooded soils*—Gray Wooded soils were extremely low in productivity when first brought into production but responded well to good management. The results of a study started on a virgin Gray Wooded soil in 1951 showed the effect of cultivation, fertilization, and crop rotation on the yield of cereals during a 12-year period. The crop rotations were as follows: (a) 2-year: grain, green manure; (b) 6-year: 2 grain, 4 hay.

Rotation	Treatment	Barley, bu per acre		
		1951	1957	1963
Two-year	Avg of: Checks	3.3	19.8	28.0
	Fertilizers	7.3	35.9	48.7
Six-year	Avg of: Checks	3.3	16.5	35.2
	Fertilizers	7.3	36.0	54.2

The 6-year rotation had the advantage of producing a crop, either grain or hay, every year rather than every other year as with the 2-year sequence.

*Beef production from fertilized cultivated pasture*—Yearling steers were used to evaluate the productivity of three pasture swards under three rates of fertilization in a 3<sup>2</sup> split plot factorial experiment replicated three times. Rotational grazing across three replicates was practiced.

From 1956 to 1958, acre yields of brome-grass-alfalfa, brome-grass, and creeping red fescue were 239, 212, and 209 pounds of liveweight gain, respectively. The respective liveweight gains per acre with no fertilizer, 33 pounds of N, and 32 pounds of N plus 40 pounds of P<sub>2</sub>O<sub>5</sub> were 187, 221, and 252 pounds. From 1959 to 1961, acre yields of brome-grass-alfalfa, brome-grass, and creeping red fescue were 302, 273, and 257 pounds of liveweight gain. With no fertilizer, 64 pounds of N plus 80 pounds of P<sub>2</sub>O<sub>5</sub>, and 128 pounds of N plus 160 pounds of P<sub>2</sub>O<sub>5</sub> the gains were 152, 314, and 366 pounds. No important fertilizer-pasture interactions were found. Carrying capacity and liveweight gains of steers were closely associated.

### Management

*Influence of stage of maturity on malting quality of barley*—Barley may be harvested when the kernel moisture is 35% without any significant decrease in malting quality. This is about the firm dough stage. The percentage heavy grade and 1,000-kernel weight increased rapidly until about 40% moisture was reached and showed little change from there to maturity. The nitrogen content and saccharifying activity increased slightly throughout the entire range. The percentage of extract was not consistent, some tests showing a slight increase and others a slight decrease with approaching maturity.

*Crop residues*—Spring tillage alone gave the poorest results in a 9-year study of handling crop residues. In the final 2 years, fall plowing and chopped straw with fall one-way disking gave the best yields. The 9-year averages showed small differences, but favored (1) fall plowing and (2) spring burning with one-way disking.

*Tillage studies*—In a fallow-grain rotation on loam soil, 4 years' results showed that the number of tillage operations in the fallow year had significant effects on yield. Indian fallow (no tillage) and two tillage operations gave lower yields than four, eight or twelve operations, which gave equal yields. Weed control was unsatisfactory on the zero and two tillage treatments and generally satisfactory on the others. The poor weed control resulted in lower soil moisture

in the fall, but the differences were negligible at seeding time. Soil samples taken in the fall of the fallow year and at seeding time the next year showed that soil nitrate was lowest with no tillage. The number of tillage operations had no appreciable effect on subsoil compaction in this test.

### Weed Control

*Wild oats* (*Avena fatua* L.)—Diallate: The series of laboratory studies (Research Report, 1958-1961) to determine the pathway and mode of herbicidal activity of diallate, a herbicide applied to the soil for control of wild oats, were completed and published in 1962. The significant finding of these studies was that the herbicide acted through the coleoptile rather than the roots or shoots of wild oats and wheat. Wheat was highly sensitive only if the coleoptile came in contact with treated soil during the first half inch of its growth, whereas wild oats were sensitive throughout. Selective control of wild oats in wheat was possible when the wheat was planted at least half an inch below a layer of treated soil. Because the relative placement of the wheat and the herbicide was critical, this point was further investigated under field conditions.

Two years of field trials at a number of sites in Western Canada showed that selective control of wild oats in wheat with diallate or triallate was feasible if the seed was planted 3 inches deep and the chemicals incorporated shallowly after seeding. The most reliable and practical means of achieving this placement of the chemical was by harrowing immediately after application. Harrowing twice helped to control wild oats slightly better than harrowing once, but did not increase crop yields. At one site in 1962 under conditions of excessive moisture and late seeding, wheat was severely injured. However, even here the injury was less with the postseeding than with the preseeding method. There was some evidence that wheat was more tolerant to triallate than to diallate. Preseeding incorporation with the disc gave slightly better weed control than postseeding incorporation with a double harrow, but again differences were not great enough to affect yield.

In the very dry spring of 1961 farmers in Manitoba noticed that wild oats was not controlled with either formulation when sprayed on air-dry soil. A laboratory project in which diallate was sprayed on air-dry soil, mixed with it, and placed above untreated moist soil in which wild oats had been planted confirmed the farmers' observations. The diallate in the air-dry soil was reactivated by the addition of water. These results suggest that the herbicide is active only in the vapor phase, but this has not been fully established.

A project to study the possible accumulation of diallate in the soil after repeated annual applications is nearing completion. There is little indication that the chemical builds up enough from three annual applications of 3 pounds per acre to seriously injure wheat.

*Tartary buckwheat* (*Fagopyrum tataricum* (L.) Gaertn.), *wild buckwheat* (*Polygonum convolvulus* L.), and *green smartweed* (*Polygonum scabrum* Moench.)—Dicamba: This herbicide has given remarkable control of these weeds as well as some other troublesome members of the Polygonaceae that are highly tolerant to 2,4-D or MCPA. However, dosage and time of treatment are critical to avoid serious injury to cereal crops, especially barley. Laboratory and field studies showed that dicamba applied to wheat and barley during periods of high meristematic activity disrupted normal growth and induced morphological and

cytological abnormalities. The intensity and locale of the morphological effects varied with the dosage and time of application. Under field conditions an application of 4 ounces per acre before the four-leaf stage caused gross malformation of the stems and leaves, reduced height, delayed maturity, and interfered with normal seed development in both crops.

Under lush conditions in the greenhouse, similar effects were induced by half this dosage. Doubling the rate of application intensified and prolonged the effects to the extent that response differences due to growth stage were largely masked. Wheat and barley seedlings, germinated in different concentrations of dicamba, showed a sharp reduction in the numbers of dividing cells, viz., 133, 109, 97, 66, and 21 in concentrations of nil, 1, 5, 10, and 100 ppm respectively. But once initiated, mitosis appeared to proceed normally. At 10 ppm and upwards, there was much evidence of chromosome clumping and the formation of multinucleate cells. Cell development and arrangement in the florets of treated plants were grossly disturbed.

Cooperative field plot studies at five sites in Western Canada have shown that dicamba alone or mixed with the amine formulations of 2,4-D or MCPA or 2,4-D plus mecoprop controlled weeds best when applied just before or at the full three-leaf stage of wheat, oats, and barley. Later treatment severely injured these crops and controlled fewer weeds. Wheat and oats tolerated as much as 2 ounces of dicamba per acre alone or in the mixtures when applied at the suggested early growth stage. Barley was more sensitive and withstood only 1.5 ounces of dicamba per acre at any growth stage. Under very lush conditions of growth some barley was injured even at this rate.

Mixtures of dicamba with 2,4-D or MCPA amines controlled more kinds of weeds than dicamba alone, as the mustards, *Cruciferae* spp. for example, have considerable tolerance to dicamba. At the same time, the additive effect of the herbicides in the mixture permits the use of smaller amounts of dicamba thereby affording greater crop safety.

In a study of its movement and persistence in the soil it was found that dicamba sprayed on loam and sandy soils moved readily with water applied on the surface. The main concentration of the herbicide followed slightly behind the penetration of the added water in both soils.

Dicamba persisted much longer than 2,4-D butyl ester in autoclaved and nonautoclaved loam and sandy loam soils. Tartary buckwheat, planted at intervals in the autoclaved soils, showed no injury from the 2,4-D at 16 ounces per acre after 4 weeks but was completely killed by dicamba at 8 ounces per acre after 12 weeks of incubation. In the nonautoclaved soils there was no visible effect on the buckwheat plants from 2,4-D after 2 weeks, but nearly all of the plants were killed by dicamba after 12 weeks.

Oxygen consumption in the loam soil was greatly reduced by dicamba at concentrations of 10,000 ppm or higher. Similar concentrations of 2,4-D butyl ester had only a slight and sometimes no effect on oxygen uptake. These concentrations are far in excess of those suggested for selective weed control in grain crops.

No attempt has been made to show buildup of dicamba in the soil due to repeated spraying. The low dosages used for selective weed control in cereals and the small amount that actually falls on the soil make the probability of crop injury from buildup appear remote. However, there would appear to be considerable hazard if substantially higher dosages were used.

*Canada thistle* (*Cirsium arvense* (L.) (Scop.)—Picloram: A summerfallow program of tilling up to mid-June and then spraying with 16 ounces of 2,4-D ester per acre as soon as the thistles reached the bud stage, and following up with further tillage to control any regrowth until freeze-up, reduced the thistle stand the next year by as much as 90%. Replacement of the 2,4-D ester with picloram at 4 to 8 ounces per acre reduced the thistle stand even more, and considerably less tillage was required. The studies with picloram are being continued to establish or refute the suggestion of injurious effects on succeeding grain crops.

*Herbicides for perennial weeds on noncrop land*—In the past decade many herbicides that have long residual effects in the soil have been developed to replace the commonly used but highly flammable sodium chlorate for the nonselective control of small patches of perennial weeds on agricultural land. In comparative field trials begun in November 1960, the *s*-triazines atrazine and simazine and the substituted ureas monuron and diuron controlled both broad-leaf and grass species for long periods. On sandy soil that had only 3 to 4% organic matter, the *s*-triazines and substituted ureas killed and prevented the regrowth of toadflax (*Linaria vulgaris* Mill.), bromegrass (*Bromus inermis* Leyss.), and couchgrass (*Agropyron repens* (L.) Beauv.) for the past four seasons. However, about double the rate of these herbicides was required to kill these species in a companion trial, only 20 miles away, on loam soil that contained 12 to 14% organic matter.

The movement of the herbicides with soil water varied considerably and strongly influenced their persistence and effectiveness. Soil cores taken to a depth of 24 inches and bioassayed with flax and oats showed that monuron had moved to a depth of 12 inches whereas diuron, simazine, and atrazine had moved less than 3 inches into the soil 1 year after application. Four years after application on the sandy soil, monuron was quite uniformly spread throughout the top 18 inches whereas the less-soluble diuron and simazine were still concentrated in the top 6 inches of soil. Atrazine, after 3 years, had moved more like simazine than monuron. The rather soluble sodium chlorate had been leached through the top 24 inches of soil so that both the flax and oats grew normally.

Bromacil at 5 pounds per acre eliminated perennial grasses through three seasons but did not reduce the stand of toadflax. Conversely, Fenac (2,3,6-trichlorophenylacetic acid; Amchem Co., Ambler, Penn.) at 7 pounds per acre controlled toadflax without harming the grass. Dicamba and picloram controlled broadleaf weeds in grasses; in tests, they also controlled couchgrass in bluegrass.

*Brush control*—Tests to study the return of brush-covered land to pasture or cereal production were initiated under dry conditions on sandy rangeland in east-central Alberta and under moist conditions on tree-covered gray soil areas of the foothills. Low-growing or shrubby plants such as western snowberry (*Symphoricarpos occidentalis* Hook.), wolf willow (*Elaeagnus commutata* Bernh.), and willows (*Salix* spp.) were most economically controlled by spraying with 2,4-D ester at 2 pounds per acre, using either aerial or ground equipment. It was usually necessary to remove the dead stems by rotary mowing to make the grass more accessible to livestock, and to spray a second time 1 or 2 years later to control woody regrowth. The increased productivity of the native grasses freed from competition with the woody species and the greater accessibility to grazing animals more than offset the total cost of \$5 to \$6 per acre.

Where wild roses (*Rosa* spp.) constituted a large part of the brush growth a mixture of 2,4-D and 2,4,5-T esters in the ratio of 2:1 sprayed at a total dosage of 2 pounds per acre controlled all of the species.

Aspen poplar (*Populus tremuloides* Michx.) and balsam poplar (*Populus balsamifera* L.) more than 20 feet high required mechanical cutting or uprooting, piling, and burning. These operations in medium stands cost \$20 to \$30 per acre, but the cost would be much higher in dense stands of larger trees. Killing the trees with herbicides nearly halved the cost of bulldozing in one test. Breaking the land by discing twice with a heavy disc (at least 3,000 pounds) provided a seedbed adequate for the establishment of cultivated forage crops. Breaking with a moldboard plow involved considerable root picking and was more expensive but did not improve the forage stand. However, the land was in sufficient tilth to permit the use of conventional equipment to seed and harvest either forage or grain crops. After plowing there was little or no regrowth whereas after discing poplar regrowth was dense and rapid and required one or two sprayings with 2,4-D ester at 2 pounds per acre to control it. Where legumes formed part of the forage mixture seeded after breaking by discing, the woody regrowth was controlled by spraying during the dormant season with 2,4-D in diesel fuel.

The cost of the combined mechanical and herbicide program of clearing, breaking, and seeding over medium-heavy poplar growth varied from \$35 to \$50 per acre. The yield of cultivated forage was about double that of the native grasses and establishment was quicker and more certain. Therefore, to realize a satisfactory return on such a large investment the clearing program should be sufficiently intense to utilize cultivated forage crops and be undertaken only on potentially arable land.

*Green foxtail* (*Setaria viridis* (L.) Beauv.)—This grassy annual weed has been spreading rapidly in central Alberta in the past decade. In field trials, fair to good selective control in barley and oats was obtained with TCA. The herbicide was sprayed at 2 to 3 pounds per acre when the weed was in the one-to three-leaf stage and the crop had two to four leaves. Since the herbicide acts primarily through the soil, better weed kills but also greater risks of crop injury resulted from treatments applied on sandy soils and just before or after a rain. This treatment often caused temporary plant deformities in barley. The benefits from the weed control, however, usually more than offset any depressing effect of the herbicide on barley yield.

## SOIL RESEARCH SUBSTATION, VEGREVILLE

The Soil Research Substation aims to solve problems associated with Solonetzic soil productivity. From 1958 to 1961 most of the effort was directed towards the characterization of the soils and the assessment of the various problems. Since then, tests showed that available nitrogen is a major limiting factor on the soils at the Substation. Trials are now under way on eight Solonetzic soil types throughout east-central Alberta, from Coronation in the Brown soil zone to Leduc in the Black soil zone, to determine if the lack of available nitrogen is general throughout the Solonetzic soil area.

### Weather

Meteorological data have been recorded at Vegreville since 1957. These records can be compared with long-term data recorded at Ranfurly (courtesy

Mr. T. D. Waite, Ranfurly, Alta.), a few miles east of Vegreville where, during the past 60 years, there was just under 18 inches of precipitation annually. This might be considered normal for the district.

Precipitation was slightly above normal in 1962 (18.98 inches), below normal in 1963 (15.46 inches), and again below normal in 1964 (15.14 inches). The figures for October 1 to June 30 may reflect more realistically the amount of moisture available for the crop year. The amount for this period for 1961-62 was 12.19 inches, for 1962-63, 9.92 inches, and for 1963-64, 5.85 inches. The lowest amount of precipitation for the period during the past 60 years was 5.57 inches, in 1957.

Frost has not been a serious problem at Vegreville. The frost-free period (above 28 F) was 120 days in 1962 and 1963, and 100 days in 1964. However, even in 1964 only bran frost damage resulted when the temperature went down to 27 F on August 24.

### **Solonetzic Soils**

*Characteristics of major soil groups*—The profiles taken for this study were from an area in which Solonetzic soils and Chernozemic soils were geographically closely associated. The chemical and physical characteristics of the Solonetz and Solodized Solonetz profiles clearly distinguished them from the Orthic Chernozemic soils. The B horizon of the Solonetz and Solodized Solonetz soils contained over 15% exchangeable sodium and had a pronounced accumulation of illuvial clay. The C horizons were quite saline, the main salt being sodium sulphate. The geographically associated Orthic Chernozemic soils exhibited none of these characteristics. The A horizons of the Solonetzic soils were more acid than the A horizons of the Orthic Chernozemic soils. The more strongly leached profiles taken in this study had morphological and chemical characteristics that were intermediate between the above two groups; some were classed as Solods and some as Eluviated Chernozemic soils.

*A nutritional disorder in barley seedlings*—Surface samples of a Solonetz and a Solod soil that occur in intimate association in the field were compared in the greenhouse from a productivity standpoint.

A nutritional disorder that developed in the crops grown on the Solonetz was diagnosed as a nitrogen deficiency. The deficiency was so severe that the Solonetz soil was incapable of sustaining the growth of barley seedlings. By applying nitrate to the soil, the production of repeated seedling crops was similar to that on the untreated Solod. During 4 weeks' incubation the Solonetz released only 13 parts per million nitrate nitrogen as compared with 46 parts per million in the Solod.

*Nitrogen mineralization*—Samples of a Solonetz and Solodic soil that occur in close proximity in the field were used to determine if factors other than the quantity of nitrogen might be responsible for the difference in the ability of the two soils to provide nitrogen to crops. The effect of altering the carbon-to-nitrogen ratio, heating, and the addition of nitrogenous compounds on nitrogen mineralization and carbon dioxide evolution from A horizon samples was studied.

Added sucrose stimulated the evolution of carbon dioxide in the Solonetz samples but added ammonium sulphate had no appreciable effect. Heat caused a direct release of ammonium nitrogen even from air-dry samples, and preheating caused a marked increase in ammonification during subsequent incubation. Both

ammonification and nitrification took place quite effectively in samples of the Solonetz soil to which a relatively simple organic nitrogen compound was added.

The factor limiting nitrogen mineralization in Solonetz soil appears to be the lack of readily decomposable organic nitrogen compounds.

*Moisture use by plants*—The depth to which crops remove soil moisture was found to be closely related to the severity of the solonetzic condition. Plants growing on Solonetz soil with a salt concentration layer close to the surface were stunted and showed little evidence of removing moisture from any significant depth. To determine if the salts present in the salt concentration layer were preventing the uptake of water and causing the stunted plant growth, sodium sulphate, the predominant readily soluble salt, was added to surface soil samples on which barley plants were grown in the greenhouse. Contrary to expectations, the addition of sodium at levels beyond those found in the soil stimulated the growth of barley seedlings even under conditions of restricted moisture supply. These results suggest that the stunted nature of the plants and their failure to extract moisture from the Solonetz soil is not directly due to the presence of the salt concentration layer.

*Deep working on Solonetz soil*—A 6-year study was conducted to determine how working a Solonetz soil to a depth of 24 inches affected its productivity and chemical and physical condition. Productivity was generally increased during the second rotation. The extractable calcium content of the A and B horizons was increased and the sodium content decreased. The magnesium distribution was not changed. An intractable B-like horizon reformed in the deep-worked plots. No relationship was found between productivity and the balance of extractable cations.

### **Nutrition and Crop Production**

Field trials at Vegreville have supported laboratory and greenhouse findings that the A horizon of Solonetz soils was incapable of supplying a satisfactory quantity of nitrogen for plant growth. An application of ammonium nitrate at 200 pounds per acre increased the yield of hay at Vegreville from an average of 876 pounds of dry matter per acre to 4,560 pounds in 1961-64. Preliminary field trials were conducted on brome grass growing on Solonetzic soils at Vegreville, Bruce, Camrose, Chipman, Coronation, Halkirk, and Kavanaugh to determine if the lack of available nitrogen was general to Solonetzic soils. The degree of response varied from one soil type to another, but on all types studied the application of nitrogenous fertilizer led to a substantial increase in production.

At Vegreville the application of nitrogen markedly changed the botanical composition of the sward. In 1961 the sward was a mixture of brome grass and Kentucky bluegrass. In the same stand in 1964, the fertilized plots produced about 90% brome grass and the unfertilized plots about 90% Kentucky bluegrass.

Urea, ammonium nitrate, and ammonium sulphate were compared at Vegreville as sources of nitrogen. When these fertilizers were applied in 1963 and 1964 to provide equal quantities of nitrogen, they were equally effective in increasing yields of hay.

The application of phosphorus in addition to nitrogen did not increase the yield of hay significantly at any location since these tests were established. The application of potassium did not significantly increase the yield of hay at any location.

Field and greenhouse studies were conducted to determine if the lack of any micronutrient might be limiting crop production on Solonchic soils. The application of boron, copper, iron, manganese, molybdenum, or zinc did not increase yields appreciably.

Sulphur and krillium were tested at Vegreville as amendments but did not increase crop yields.

### **Forage Crops**

At Vegreville, bromegrass was as productive as intermediate wheatgrass or creeping red fescue and somewhat more productive than crested wheatgrass, reed canarygrass, meadow fescue, and timothy. During the 5-year period ending in 1964, bromegrass yielded an average of about 3,600 pounds of dry matter per acre, intermediate wheatgrass 3,550, creeping red fescue 3,500, crested wheatgrass 3,050, reed canarygrass 3,000, meadow fescue 2,900, and timothy 3,200. Until 1964, bromegrass had outyielded creeping red fescue, but the fescue made considerably better growth under the very dry conditions that prevailed in that year.

Establishing stands of alfalfa has not been difficult since the method of seeding was changed to drill from broadcast seeding. When alfalfa was seeded with grasses, the grasses dominated the mixture in the second and subsequent years after seeding. However, where a pure stand of alfalfa was seeded in rows it persisted quite well from 1960 to 1964. The yields in the 5 years were about 3,800, 2,500, 2,800, 3,400 and 2,200 pounds of dry matter per acre.

Little difficulty has been experienced in establishing stands of sweet clover at Vegreville, but for some undetermined reason a worthwhile crop was harvested in only one year in seven.

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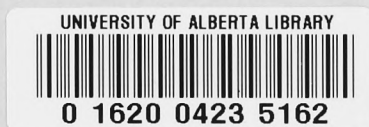
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